New Schiff Base Ligands and Their Transition Metal Complexes: A Study on Coordination, Reactivity and Biological Potentials

SYNOPSIS

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BY

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SYNOPSIS OF RESEARCH WORK FOR Ph.D. DEGREE IN THE FACULTY OF SCIENCE (CHEMISTRY)

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1. TITLE OF THE RESEARCH WORK

NEW SCHIFF BASE LIGANDS AND THEIR TRANSITION METAL COMPLEXES: A STUDY ON COORDINATION, REACTIVITY AND BIOLOGICAL POTENTIALS

INTRODUCTION

Schiff bases and their metal complexes occupy an important position in coordination chemistry due to their structural diversity, ease of synthesis, and wide range of biological applications. Schiff bases, formed typically by the condensation of primary amines with carbonyl compounds, act as versatile chelating ligands capable of binding to metal ions through azomethine nitrogen and other donor atoms. Transition metal complexes of Schiff bases exhibit remarkable activities such as antimicrobial, anticancer, antioxidant, anti-inflammatory, antiviral and enzyme–inhibitory properties. Their biological potential arises from the modification of electronic properties, improved lipophilicity upon chelation, and stabilization of reactive conformations. The proposed work seeks to design new Schiff base ligands and synthesize transition-metal complexes, followed by complete physico-chemical, spectroscopic, and biological evaluation. This multidisciplinary work is in line with modern chemistry's increasing role in tackling biological problems

WORK PLAN

A. PURPOSE AND NEED OF THE STUDY: -

The study is motivated by:

1. Growing demand for new metal–based therapeutic agents with improved potency and selectivity.
2. Schiff bases serving as privileged ligands due to synthetic flexibility and biological relevance.
3. Transition metals (Cu, Ni, Co, Zn, Fe, Mn, etc.) exhibiting synergistic biological effects when complexed with organic ligands.

4. Limited systematic studies combining novel Schiff-base design, metal coordination chemistry, and biological evaluation.
5. Increasing global interest in developing drug candidates from structurally diverse molecules, inspired by previous work in heterocycles and natural-product-like structures

This study aims to contribute new knowledge to coordination chemistry and bioinorganic chemistry by providing structurally novel and biologically relevant metal–ligand systems.

Review of Literature of proposed work

This section will include:

- Classification, chemistry, and applications of Schiff bases.
- Mechanisms of coordination to transition metals.
- Previous studies on the biological properties of metal–Schiff base complexes.
- Factors influencing bioactivity: geometry, electronic structure, chelation, redox properties.
- Recent advances in metal-based therapeutics and ligand design.
- Challenges in tuning selectivity, solubility, and stability of such complexes.

The synopsis will reference methods similar to the sample literature review approach in the uploaded file, which surveys previous works systematically

B. DETAILS OF THE PROJECT WITH CHAPTERIZATION: -

Chapter- I : Introduction
Chapter- II : Survey of previous works
Chapter- III : Experimental
Chapter- IV : Result and Discussion
Chapter- V : Conclusion

C. HYPOTHESIS: -

1) **Design and synthesize novel Schiff base ligands** using substituted aldehydes/ketones and primary amines.
2) **Prepare transition metal complexes** of synthesized ligands using Cu(II), Co(II), Ni(II), Zn(II), Mn(II), and Fe(III) salts.

Characterization ligands and metal complexes via:

- IR, UV–Vis spectroscopy
- NMR
- Mass spectrometry
- Elemental analysis
- Magnetic susceptibility measurements
- Conductivity and thermal analysis

Evaluation of biological activities, including:

- Antimicrobial (bacterial and fungal)
- Molecular docking (optional computational component)

Establish **structure–activity relationships (SAR)** based on variations in ligand structure, metal ion type, and coordination geometry.

D. METHODOLOGY: -

Synthesis of Schiff Base Ligands

1) Condensation of substituted aromatic/aliphatic aldehydes or ketones with suitable amines under reflux or solvent-free conditions.
2) Purification through recrystallization or chromatography.

Synthesis of Transition Metal Complexes

1) Reaction of ligands with metal salts (acetates, chlorides, nitrates) in appropriate stoichiometric ratios.
2) Isolation of complexes by precipitation, filtration, or solvent evaporation.

Characterization

1) **Spectral studies:**
   IR (C=N stretching shifts), UV–Vis (d–d transitions), NMR (ligand identity).
2) **Mass spectrometry & elemental analysis:** Confirmation of molecular composition.
3) **Thermal analysis:** TGA/DTA for stability profiling.

Biological Screening

- Antibacterial and antifungal assays using standardized strains.
- **DNA binding and cleavage studies** to explore chemotherapeutic potential.

E . BIBLIOGRAPHY:-

1) Todarwal, M. A., Tadavi, S. K., Sancheti, R. S., & Bendre, R. S. *"Synthesis, Characterization, DFT, Biological Activities and Molecular Docking Analysis of Schiff Base Ligand and Its Transition Metal Complexes."* **European Journal of Chemistry**, Vol. 15 No.2 (2024): 128-142.

2) Ndiolene, A.; Diop, T.; Boye, M. S.; Faure, B.; Diasse-Sarr, A.; Giorgi, M. "Synthesis, Characterization, and Antimicrobial Activity of Cu(II) and Zn(II) Complexes With N,N-bis(4-methoxybenzylidene)ethylenediamine or N-(4-methoxybenzylidene)ethylenediamine Schiff Base." *European Journal of Chemistry*, 2025, **16**, 169–177.

3) Mahdy, A., Zahra, J. A., Haddadin, R. N., Al-Hiari, Y., & Kasabri, V. *Multi-biological activity evaluation of Sn(II), Zn(II) and Fe(II) complexes based on thiocarbohydrazide Schiff bases: synthesis, spectroscopic investigations and fluorescence studies.* **Scientific Reports**, **15**, Article 31757 (2025 Aug 28).

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